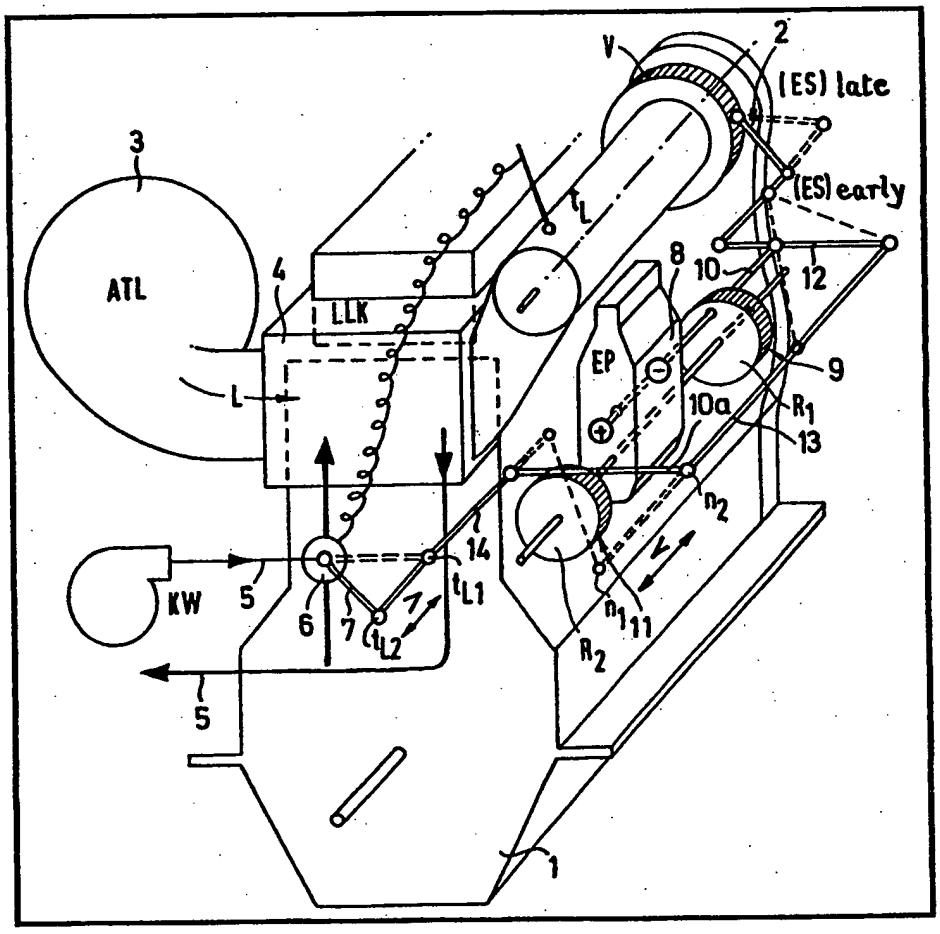
(12)UK Patent Application (19)GB (11) 2018352 A

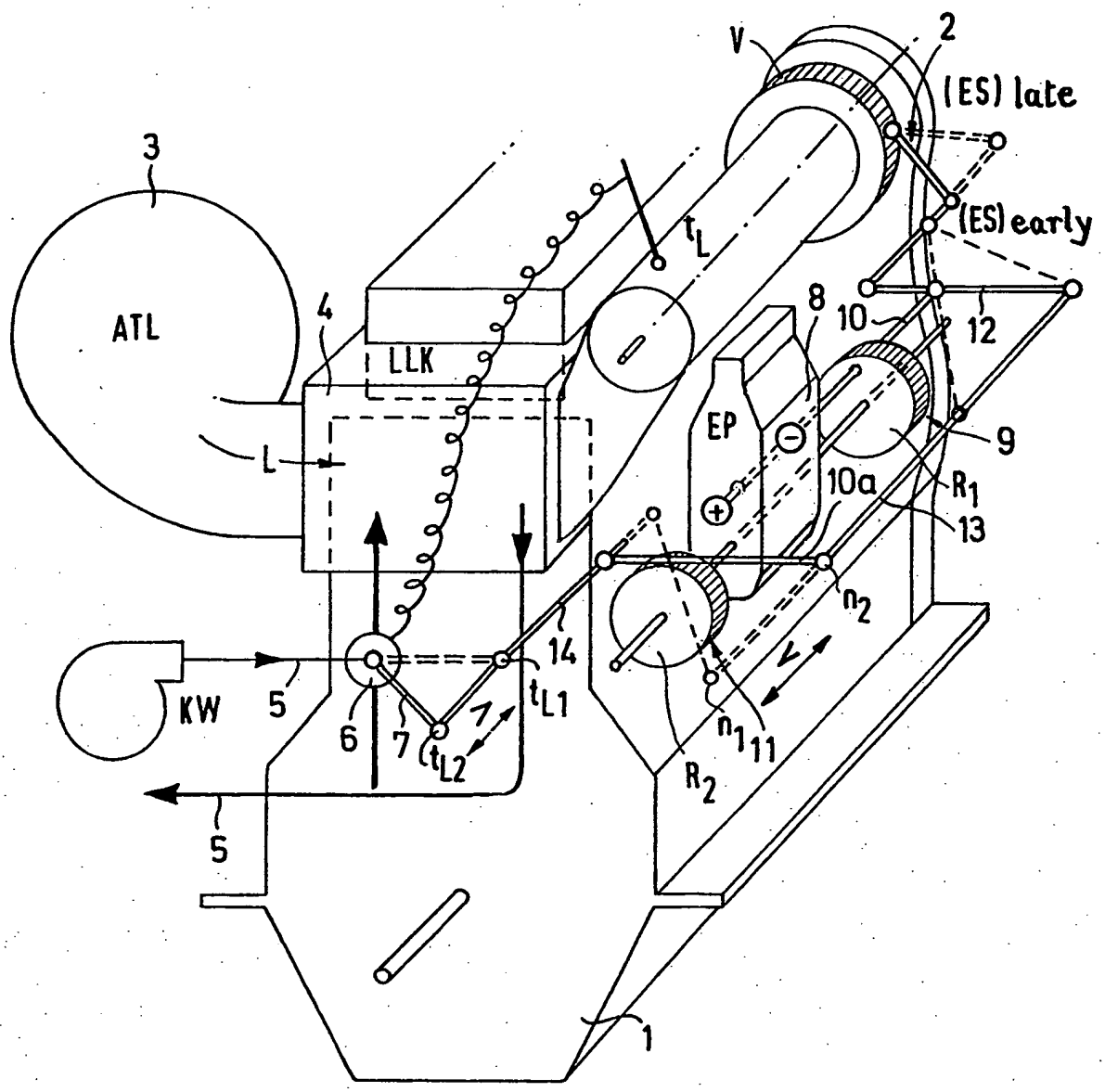
(21) Application No 7910814
(22) Date of filing
28 Mar 1979
(23) Claims filed
28 Mar 1979
(30) Priority data
(31) 2814343
(32) 3 Apr 1978
(33) Fed Rep of Germany (DE)
(43) Application published
17 Oct 1979
(51) INT CL² F02D 23/02 13/02
(52) Domestic classification
F1B 2B13A 2B13F 2B1 2B4
(56) Documents cited
GB 1277989
GB 1190948
GB 1092113
GB 1034261
GB 896659
GB 836265
GB 821799
GB 805640
GB 772392
GB 739740
GB 712613
GB 672485
(58) Field of search
F1B
(71) Applicant
Klöckner-Humboldt-Deutz Aktiengesellschaft
5000 Cologne 80
German Federal Republic
(72) Inventor
Johann Keylwert
(74) Agents
Bromhead & Co

(54) Control system for a Diesel engine

(57) A control system for a Diesel engine supercharged by an exhaust-gas driven supercharger, comprises adjustment means (2) for the timing of the inlet valve closure, and an engine governor (9) which adjusts the quantity of fuel injected to maintain the power output equilibrium as a function of engine speed, in which the engine governor (9) also actuates the adjustment means (2) in dependence upon the amount of fuel injected. Charge air temperature may also be regulated.



2 9


V
2
(ES) late
(ES) early
3
ATL
4
LLK
t_L
8
10
12
EP
9
10a
R_1
13
L
n_2
14
KW
5
6
7
t_{L1}
t_{L2}
n_1
11
R_2
5
1

SPECIFICATION

Control system for a Diesel engine

This invention relates to a control system for a Diesel engine, more particularly a Diesel engine supercharged by an exhaust-gas driven supercharger, comprising adjustment means for the gas change valve timing, more particularly the timing of the inlet valve closure, an engine governor which adjusts the injected quantity required to maintain the power output equilibrium, as a function of the engine speed.

Highly supercharged reciprocating-piston engines equipped with superchargers display poor torque and part-load behaviour. On encreasing the power demands in the part of the installation driven by the engine, the engine governor reacts initially by increasing the quantity of fuel injected and thus re-establishing the power output equilibrium. However, once the maximum limit of injected quantity is reached the speed falls when the power demand by the installation rises further. During this phase the amount of exhaust gas decreases in correspondence with the decrease in delivered power; the consequence is a rapid fall in the turbocharger speed. As the charger speed falls the supercharging pressure also falls drastically, and the weight of air available in the cylinders is no longer sufficient to burn the injected maximum quantity of fuel. The engine consequently becomes thermally overloaded and begins to smoke.

To achieve high mean working pressures, the pressure ratios of the turbocharger need to be correspondingly high, among other steps, this presupposes a tuning of the turbocharger to enable it to work at the maximum efficiency over the full-load operating range. The characteristics of the operating diagrams of centrifugal machines are such that at high efficiencies the operating co-ordinates lie close to the charge pumping limits. This means that during tuning the full-load operating co-ordinates inevitably closely approach the pumping limits of the charger. This position in the diagram, in turn, entails that when the load on the engine is reduced the pumping limit may even be exceeded. As a result the operating state of the engine is put at risk. This sensitivity is even more evident, when two turbochargers work in series to obtain the maximum mean working pressure (double supercharging).

It is known (Nordberg-Miller gas engine) to alter the timing of the intake valve closure and hence to alter the effective intake stroke of the working piston, more particularly to shorten it. In this way the final compression pressure and temperature can be influenced independently of the precompression pressure ratio.

It has been found that engines which use the Miller process timing display the above-named sensitivity to a much lesser degree. Tests carried out by the Internal Combustion Engine Research Group of the VDMA confirm this.

The aim of the present invention is to modify or extend a control system of the type described above in such a way that both the torque and the part-load behaviour of the engine are improved. During all operating states there is to be a safeguard that the permissible maximum final pressure and final temperature of the gases of combustion in the working cylinder are not exceeded.

The solution to the aim of the invention is achieved by providing a control system for a Diesel engine, more particularly a Diesel engine supercharged by an exhaust-gas driven supercharger, comprising adjustment means for the gas change valve timing, more particularly the timing of the inlet valve closure, and an engine governor which adjusts the quantity of fuel injected to maintain the power output equilibrium as a function of the engine speed, in which the engine governor also actuates the adjustment means for the gas change valve timing in dependence upon the amount of fuel injected in the sense that, when the amount of fuel injected is reduced, the timing of the inlet valve closure is adjusted from "early" to "late".

To optimize an engine provided with variable valve timing equipment for all loading states, the object must be to achieve approximately uniform final compression temperatures. In using the invention, timing of the closure of the intake valve is adjusted from early to late in dependence on the amount of injected fuel. The result is that the rapidly falling compression ratio of the precompression in the turbocharger is approximately balanced out by a lengthening of the effective compression stroke of the working piston. An over-rapid fall in the final compression temperature during part-load operation is countered in this way. The operating behaviour of the engine is consequently improved without producing excessive pressure and temperature, which represent a risk over the full-load operating range.

For starting the engine the full intake stroke is needed to attain an adequate ignition temperature and no supercharging pressure augmented by the exhaust-gas turbocharger is then available. The invention therefore proposes a temporary interruption of the connection between the engine governor and the adjustment means during starting of the engine.

An advantageous embodiment of the invention provides improved torque characteristics. When the engine governor has reached the maximum injection limit the speed falls, as has been described above. However, the second governor or further control function now takes over to the extent that it intervenes in the adjustment mechanism of the governor

and reverses the intake valve closing change by the engine governor by way of the amount injected. In this way it once more increases the effective intake stroke of the working piston. This step is advisable because the turbocharger speed begins to diminish from then on and the boost pressure decreases. The effect is reduced and the weight of air available is increased by adjusting the intake valve closure to late.

An advantageous further embodiment enables the torque characteristic of the engine to be further improved by influencing the charging air temperature of the charge-air cooler. The second governor or further function can alter the coolant temperature of the cooler in such a way that the same is reduced as the speed falls. Consequently, a greater weight of charging air is aspirated, thus once more countering the loss in torque.

Influencing of the timing adjustment means is effected in an advantageous manner by providing a balance beam on whose ends the adjustment means itself and the final control element of the second governor or governor further function engage, and by connecting the engine governor final control element to the central region of the beam. In accord with the desired torque versus engine characteristics behaviour, the point of engagement of the engine governor final control element or of the final control element of the second governor and the final adjustment means can be varied on the balance beam.

The accompanying drawing shows one embodiment of the invention in simplified form and the invention will now be described in greater detail with reference to the drawing.

In the drawing, reference 1 generally denotes a Diesel engine, which is constructed in the usual way and has a crankshaft, working pistons connected thereto, and one or more cylinders with cylinder heads and gas-change ducts. An adjustment means 2 for varying the timing of the closure of the inlet valves (not shown) is mounted ahead of the inlet manifold. The adjustment means can consist of cam followers mounted in front whose angular position with respect to the crankshaft is variable. Reference numeral 3 denotes an exhaust-gas driven turbocharger constructed in the usual way and consisting of a turbine and coupled compressor which leads the compressed air to a charge-air cooler 4. The charge-air cooler 4 is cooled by coolant fed and discharged via coolant lines 5. The coolant temperature can be controlled via a thermostat 6 with a basic adjustment means 7. Reference numeral 8 denotes a fuel injection pump driven by the engine which is shown diagrammatically. The fuel injection pump 8 is controlled by a governor 9 which adjusts the quantity injected by the injection pump and has a free final control member 10. Reference numeral 11 denotes a further governor also driven by the engine and with a final control member 10*a* acting in dependence on the speed of the engine. Reference numeral 12 denotes a balance beam whose one end is engaged by the timing adjustment means 2 and whose other end is engaged by a rod 13 leading to the control member 10*a* of the governor 11. The control member 10 of the governor 9 engages at the central region of the balance beam 12 and a further system of rods 14, linked to the basic adjustment means 7 of the thermostat 6, engages on the control member 10*a* of the governor 11.

If now the power output requirement is increased at substantially constant speed, the speed will initially fall since the engine governor requires a certain minimum reduction in speed to respond, then the governor 9 increases the quantity of fuel injected. At the same time it alters the inlet valve closure timing from late to early, and vice versa. If this increase in output by the engine is not enough, and if the amount injected is at its maximum limit, the result is a fall in speed. The governor 2 now intervenes and reduces the charge-air temperature by way of a basic adjustment of the thermostat and a reverse shift of the intake valve closure timing from early to late, thus incrasing the engine speed. A combined governor with two mutually independent output ends can achieve the same mechanism of action. Use of the control system in combination with the adjustment of the effective intake stroke of the working piston improves the torque characteristics considerably, more especially at high supercharge rates.

CLAIMS

1. A control system for a Diesel engine, more particularly a Diesel engine supercharged by an exhaust-gas driven supercharger, comprising adjustment means for the gas change valve timing, more particularly the timing of the inlet valve closure, and an engine governor which adjusts the quantity of fuel injected to maintain the power output equilibrium as a function of the engine speed, in which the engine governor also actuates the adjustment means for the gas change valve timing in dependence upon the amount of fuel injected in the sense that, when the amount of fuel injected is reduced, the timing of the inlet valve closure is adjusted from "early" to "late".

2. A control system according to claim 1, in which, during starting of the engine, the connection between the engine governor and the adjustment means for the valve timing is interrupted temporarily, and closing of the inlet valves is adjusted to late.

3. A control system according to claim 1 or claim 2, comprising a further governor or a further contral function from the engine governor which intervenes in the actuating means

between the engine governor and the timing adjustment means or in the adjustment mechanism of the engine governor in the sense that, when the engine speed decreases, timing of the inlet valve closure is adjusted back from early to late when the full-load speed is not reached.

4. A control system according to claim 3, comprising charge-air cooler having means to adjust the coolant temperature, preferably controllable by a thermostat, in which the further governor or the further control function from the engine governor controls the coolant temperature or the basic adjustment of the thermostat in dependence on the speed of the engine in the sense of reducing the charging air temperature when the engine speed falls.

5. A control system according to any preceding claim, comprising a balance beam whose ends are respectively acted upon by the adjustment means for the timing and the control member of the second governor or the further control function and whose central region is coupled to the control member of the engine governor.

6. A control system for a Diesel engine, more particularly a Diesel engine supercharged by and exhaust-gas driven supercharger, comprising adjustment means for the gas change valve timing, more particularly the timing of the inlet valve closure, and an engine governor which adjusts the quantity of fuel injected to maintain the power output equilibrium as a function of engine speed, constructed and arranged substantially as herein described, with reference to and as illustrated in the accompanying drawing.

Printed for Her Majesty's Stationery Office
by Burgess & Son (Abingdon) Ltd.—1979.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.